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Case Report

From vision to reality: How human factors can inform the design of cardiac diagnostic services in community settings

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ABSTRACT

Introduction: Expanding diagnostic capacity in healthcare systems requires new service delivery models like Community Diagnostic Centres (CDCs). Designing effective diagnostic services in the community requires attention to the practical realities of the work system in addition to the clinical vision.
Methods: This study applied a human factors approach through the Systems Engineering Initiative for Patient Safety (SEIPS) model to inform the design of community cardiac diagnostic services, focusing on workforce design and the potential role of cardiac physiologists. The study setting was a cardiology department at a community hospital. Data were collected through observations, interviews and focus groups. Data were analysed using SEIPS and Thematic Analysis.
Results: The analysis revealed three overarching design considerations: (1) Promoting professional growth and autonomy for the cardiac workforce in the community. (2) Focusing on the needs of patients in the community, including accessibility and communication. (3) Facilitating communication across organisational boundaries, particularly between CDCs and General Practitioners (GPs).
Conclusion: Human factors offers valuable insights to bridge the gap between clinical vision and practical implementation of CDCs. Addressing identified design considerations can ensure effective workforce models, patient-centred care, and seamless collaboration within the healthcare system.
Implications for practice: Integrating human factors expertise into community diagnostic services design and implementation teams can contribute to patient-centred services and effective workflows. This requires access to specialised human factors expertise. Providers of diagnostic services could consider embedding human factors expertise into their settings and tap into existing educational human factors frameworks.

1. Introduction

There is a considerable shortfall in diagnostic capacity in the National Health Service (NHS) in England and in health systems worldwide. A key health policy for improving diagnostic capacity is the establishment of new service delivery models, such as Community Diagnostic Centres (CDC) to provide elective diagnostic services in the community (Richards, Maskell, Halliday & Allen, 2022). The design of new service delivery models is usually driven by a clinical vision and understanding of the diagnostic pathway, but this should be complemented by a detailed understanding of the practical realities of how a service would be delivered.

The Richards, 2020 review (Richards, 2020) set out a vision for the expansion of diagnostic capacity in the NHS in England. Demand for diagnostic activity is increasing continuously at significant rates, e.g., computed tomography (CT) scanning (6.8% per year), magnetic resonance imaging (MRI) (5.6% per year) and echocardiography (5.7% per year) (Richards, 2020). Exacerbated by the COVID-19 pandemic, the number of patients waiting for more than six weeks for a diagnostic test has increased to the point that it has become unsustainable. NHS England releases monthly data on diagnostic wait times, which suggest that in February 2024 334,900 patients were waiting for more than six weeks for one of 15 key diagnostics tests. This represents 20.8% of the total number of patients wating at the end of the month, and far surpasses the

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target of 1%. The Richards review makes several recommendations for improving diagnostic capacity in healthcare. These include increasing the availability of diagnostic equipment and the use of novel technologies, such as artificial intelligence (Hardy & Harvey, 2019; Malamateniou et al., 2021). Additionally, the review calls for providing better opportunities for career progression and job satisfaction for the diagnostic workforce, alongside the development of new diagnostic service delivery models.

Community Diagnostic Centres form a key part of the national vision for new service delivery models, with 159 CDCs providing diagnostic services in England (April 2024). Elective diagnostic pathways have traditionally been provided by acute sites with patients referred by a general practitioner (GP) to a hospital specialist. This creates additional pressures on acute care providers and involves potentially unnecessary travel and delay for patients. The introduction of CDCs provides an opportunity to move routine diagnostic services closer to patients into the community and to reduce unnecessary hospital visits. CDCs are separate to acute diagnostic facilities, thereby relieving pressure on acute services while also reducing the risk of cancellations when more urgent cases at an acute site would take priority. CDC clinics could be staffed using new models, such as services led by clinical scientists (a healthcare scientist registered with the Health & Care Professions Council) and allied professions (Stain, Cheshire, Ross & Ridge, 2020), but current vacancy rates (7.6% in the NHS in England at the end of 2023 according to the NHS Vacancy Statistics) and lack of sufficient numbers of appropriately qualified staff could lead to a misalignment between demand and workforce supply.

Consideration of the potential contribution of human factors to the design and delivery of diagnostic services has frequently been limited to issues related to physical ergonomics to reduce musculoskeletal disease (Goyal, Jain & Rachapalli, 2009) and aspects of non-technical skills (Pang, Patel & Pilkington, 2015), such as teamworking. Traditionally, the vision of new service delivery models is described from a clinical perspective, e.g., chronic breathlessness or cancer-related pathways, but this design approach risks potential mismatches with how specific clinical systems work in practice. From a human factors perspective, new service delivery models should be regarded as instances of complex *socio-technical* interventions rather than only clinical interventions. The clinical vision of service delivery models and diagnostic pathways can be thought of as work-as-imagined (WAI), i.e., work as might happen under idealised and routine situations, abstracted from the realities of the actual work system. However, the complexity of clinical systems and the variability and uncertainty involved in most clinical activity means that everyday work, or work-as-done (WAD), will often differ significantly from these idealised assumptions (Hollnagel, 2015). It is, therefore, important to consider the wider socio-technical system already at the design stage of new service delivery models.

Increasingly there is a recognition of the broader scope of human factors as a scientific discipline and a professional practice based on systems thinking (Russ et al., 2013; Sujan et al., 2021). This is driven to a significant extent by research and policy in patient safety (Spurgeon et al., 2017). In the NHS in England, the national patient safety strategy includes a focus on human factors, which is realised through the national patient safety syllabus and the new Patient Safety Incident Response Framework (PSIRF). The PSIRF replaces the previous Serious Incident Framework, and it is based on the Systems Engineering Initiative for Patient Safety (SEIPS) model (Carayon et al., 2006; Holden & Carayon, 2021) and thinking in resilient health care (Hollnagel, Sujan & Braithwaite, 2019). The SEIPS model represents system and individual outcomes as produced by higher-level processes, which in turn are delivered through context-dependant interactions of elements of the work system, such as people, tools and technologies, tasks, and the physical, organisational and external environments. SEIPS was chosen as the analysis framework for this study because of its systems focus and outcome-orientated approach, which includes a range of systems outcomes. In addition, SEIPS is well established in healthcare, e.g., in NHS policy, and it is supported by an increasing body of literature.

2. Problem statement

The aim of this study was to apply a systems perspective based on SEIPS to inform the design of community cardiac diagnostic services with a particular focus on workforce design and the potential for the role of the cardiac physiologist in the community.

3. Methods

3.1. Study design

A Human Factors / Ergonomics analysis was undertaken using multiple methods in a single community setting. Data collection and data analysis were informed by the SEIPS model. SEIPS was developed from the early 2000s onwards to integrate concepts from engineering, human factors and Donabedian's model for evaluating the quality of care (Donabedian, 1988). The original SEIPS focused on highlighting the importance of considering interactions of the different elements of a work system (Carayon et al., 2006). Subsequent versions of the model then added further emphasis to consideration of adaptations and feedback (SEIPS 2.0) and consideration of the patient journey, which typically crosses several work systems (SEIPS 3.0) (Carayon, Wooldridge, Hoonakker, Hundt & Kelly, 2020; Holden et al., 2013).

Structuring data collection and analysis around SEIPS is a frequently used overall study design within the field of HF/E in healthcare, which has been used, for example, in the ergonomics analysis of a magnetic resonance imaging (MRI) work environment (Pickup, Nugent & Bowie, 2019) and to explore barriers and facilitators in care transitions (Carman, Fray & Waterson, 2021). The present study focused on the cardiology department of a community site to identify system design considerations and opportunities for the design of the delivery of cardiac diagnostic services in CDCs and other community sites.

3.2. Setting

The study site was a community hospital in southwest London. The site is part of a larger NHS Foundation Trust, which also includes an acute hospital as well as several health centres. The focus of the analysis was the cardiology department at the community hospital.

The cardiology department offers a range of services, including echocardiography, electrocardiogram (ECG) and Holter monitors, pacemaker clinic and rapid access chest pain clinic. Services are run in conjunction with the acute hospital. At the community hospital, cardiac diagnostic services are managed by a senior cardiac physiologist (NHS Agenda for Change band 8a), and they are delivered by physiologists rotating in from the acute site (band 7 for echocardiography and pacemaker clinic) as well as physiologists working permanently at the community hospital (band 3 – 6 for ECG and Holter monitors).

3.3. Data collection

Data were collected during October 2021 – March 2022. Initially, two site visits were undertaken to provide familiarisation with the department staff and with the types of diagnostic activities performed. Then, staff were shadowed during a series of site visits for a total of 51 h of observation, see Table 1. Data collected during the observations were mostly qualitative, describing the tasks people undertake, the tools they use, and the physical spaces they work in. Following the identification of tasks, quantitative data were collected regarding durations of these tasks.

In addition, ten interviews and three workshops were undertaken to discuss the potential role and setup of cardiac diagnostic services in the community. Participants for the workshops and interviews were identified based on their involvement with cardiac diagnostic services in the

Table 1
Overview of staff grades / roles observed (duration in hours).

Staff grade / role	Observation duration (h)
Physiologist 8a	8.5
Physiologist 7 (Echo)	7
Physiologist 7 (Pacing)	3.5
Physiologist 6	10.5
Physiologist 4	16
Admin	5.5

community, either at a strategic level or through provision of such services at different grades. Other relevant stakeholders who contribute to the pathway but do not work in the community setting were excluded, e.g., family doctors and specialists in the acute site. This was a pragmatic choice due to access to participants outside of the study site and for resource considerations. Table 2 gives an overview of the number of interview participants by role, and the number of workshop participants by the perspective they were intended to bring to the workshop. Each workshop considered the design of cardiac diagnostic services in the community from a particular and complementary perspective: clinical scientist, acute site, and CDC. The interviews and workshops were semi-structured using the elements of the work system from SEIPS (people, tasks, tools and technologies, physical / organisational / external environments), and sought to examine important interactions between these work system elements. Interviews and workshops were undertaken online using Microsoft Teams. Notes were taken during the interviews for subsequent analysis. For the purpose of this HF/E analysis, audio recording of interviews was not deemed necessary as a verbatim record of what was said was not required.

3.4. Data analysis

Data from the observations, interviews and workshops were themed (Saldaña, 2009) using both inductive (codes derived from what people said or from field notes) and deductive approaches (codes derived from SEIPS framework). First, data were coded inductively using open coding in order to capture the essence of the corresponding datum. Then, the codes were grouped, and data were re-coded deductively using the elements of the work system from SEIPS, i.e., each datum has two codes, one derived inductively and one derived deductively. Lastly, themes were developed by looking at interactions between the elements of the work system.

Task durations were calculated and represented using simple descriptive statistics (mean and range).

4. Results

The findings are described first in terms of important characteristics of individual elements of the work system, and second in terms of sets (i.e., themes) of important interactions between elements of the work system, which can inform the design of community cardiac diagnostic services.

Table 2
Overview of number of interview and workshop participants.

Interview participants / role	Number	Workshop participants / perspective	Number
Senior (divisional director, services lead, senior physiologist)	5	Clinical scientists	3
Physiologist working in the community	4	Acute site cardiology	2
Admin / booking	1	CDC	2

4.1. Findings from SEIPS categories

The key characteristics of the different elements of the work system are summarised in Table 3. This type of SEIPS summary is referred to as PETT (People, Environments, Tasks, Tools) scan in the HF/E literature (Holden & Carayon, 2021).

From a patient perspective, the location and accessibility of the community site are important. Particularly in urban areas such as London, patients might pass several hospitals on their way to the community site, which can be counterintuitive and frustrating. Patients have different physical capabilities and requirements, e.g., regarding access, mobility, and transport; language might be a barrier; some people might have visual impairments and struggle to read signs and documents. Patients should also be able to experience their journey through the pathway in a joined-up way rather than as a collection of disjointed and separate services, including the transfer and discussion of information about their care from one site to the next. All staff working in community sites should have their health, wellbeing and security needs met, e.g., relating to musculoskeletal injury risk, psychological safety and the impact of workload and stress. The workforce in the community needs to feel valued and requires opportunities for career development and progression, e.g., around the ability to demonstrate adequate continuous professional development.

They physical environment at the site was crowded and busy. There was no room for additional diagnostic equipment even if this were to become available. The reception area was very busy with staff having to access areas directly behind the receptionist, causing disruptions and delays. The organisational setup and staffing arrangements leave the receptionist having to deal with administrative and patient-facing tasks concurrently. As a result, specialist staff often need to help out with these tasks, e.g., answering phones and booking in patients. In this instance, good teamwork can compensate for poor organisational design, but it means staff may need to work beyond their roles and specialists' time is used inefficiently. This is exacerbated by external factors, such as the shortage of qualified senior cardiac physiologists, which make recruitment even more challenging.

Physiologists working in the community are engaged in a range of cardiac diagnostic tasks including echocardiogram, pacing clinics, and Holter analysis. Analysis of task durations showed that staff spend considerable amounts of time on admin-related tasks. Junior physiologists doing Holter analysis can spend as much as 63% of their time on administrative tasks. While a significant part of this (44% overall) is related to clinical administration, such as cleaning and storing Holter monitors, 19% of their time is spent on unrelated non-clinical administration tasks. Senior physiologists doing echocardiograms spent on average 26 min with the patient (out of 45 min assigned to the treatment slot). However, physiologists suggested that tasks, such as cleaning and walking to fetch the patient, were welcome activities providing diversity, while also guarding to a certain extent against risks of musculoskeletal disease resulting from prolonged static one-sided working position.

Staff use a large variety of tools and technologies. During the analysis issues with usability were highlighted. For example, staff reported that software of pacemakers and electrocardiogram equipment can cause problems. Staff have to manage different operating systems and interfaces for different types of pacemakers because these are not standardised. Software updates can cause disruptions to established ways of working and workflows. The ECG machines changed functionality following a software update, which removed features staff had become accustomed to using. As a result, staff needed to change their working practices, which then involved manually scanning ECG traces rather than transferring them directly from the ECG machine. This impacted efficiency as individuals lost time due to technology issues.

Table 3
Overview of SEIPS work elements analysis.

Work system element	Description	Characteristics
People	Cardiac diagnostic services in the community require people from different departments and organisations to collaborate, for example patients, their family members, carers, clinical and administrative staff in the community setting, hospital-based specialists, managers, staff working in community roles, and the patient's GP. All these people and roles have diverse needs and capabilities.	Patients: • Need to access diagnostic services in their local community, closer to their home. • Need the delivery of services to be responsive to their specific needs and circumstances. • Can find communication with different teams on the same issue confusing, e.g., receiving appointment reminders from a central team rather than their local healthcare providers. GPs: • Require access to specialist expertise as well as diagnostic facilities. • Need clear referral pathways and criteria, and easy access to booking systems. • Some diagnostic activities could be carried out in the GP practice. • Reporting of diagnostic results to primary care should be standardised. Physiologists: • Require learning and development opportunities and exposure to a range of skills and presentations. • Require suitable supervision arrangements to ensure competency and career progression.
Environments (physical, organisational, external)	The layout, physical spaces and the positioning of equipment contribute to safe and efficient care. Organisational structures and processes affect the culture, tools and technologies available to staff, and staffing levels. External targets can add pressures, and policies influence priorities as well as the availability of qualified staff.	Physical: • Every room is taken up by existing diagnostic equipment or used as office space for analysis and reporting. There is no space to house additional diagnostic equipment even if it were to become available. • The admin workspace houses two IT workstations, a printer, and various stationary and other office items in a very narrow space. Team members who need to access the printer need to squeeze in behind the admin staff working at the IT system, causing frequent interruptions and distractions for the admin staff. • There are no patient facilities in the department. Patients need to leave the department and come back. This is inconvenient, and some patients might get confused or lost. Organisational: • The reception and administrative tasks within the cardiology department are allocated to a single receptionist role. Owing to multiple task demands (answering the phone, talking to patients etc.), administrative tasks such as appointment bookings were interrupted up to seven times per booking. All grades of clinical staff were observed to provide reception and phone cover and to pick up administrative tasks. This was regarded as good teamwork, but it can take between 15 – 25 min out of a specialist's day. • Analysis and review tasks of Holter monitor traces are done in isolation, with little feedback and opportunities for learning for junior physiologists. External: • The Richards review set strategic aims, but implementation details were unclear. There is a national shortage of qualified senior-level physiologists.
Tasks	Task inventories were developed for echocardiogram, pacing clinic and Holter analysis. Echocardiogram and pacing clinic were delivered by experienced physiologists (band 7). Holter analysis was carried out by junior physiologists (band 4).	Echocardiogram: • Assigned duration for a treatment slot is 45 min. • Mean duration of patient contact was 26 min (range 19 – 41 min). • Remainder of the time was spent on measurements after the patient had left, cleaning of equipment and report writing. Pacing clinic: • Assigned duration for a treatment slot is 20 min. • Mean duration of patient contact was 19.5 min (range 15 – 29 min). • Assigned treatment slot does not include report writing, which takes place separately (treatment slots in the morning, report writing in the afternoon). Holter analysis: • Staff doing Holter analysis spend 63% of their time on administrative tasks (clinical and non-clinical). • Staff highlighted inefficiencies around communication with GPs, where better integrated IT systems could reduce duplicate work and save up to 30 min per shift.
Tools and technologies	Tools and technologies include diagnostic equipment such as ECG and echocardiography machines, blood pressure cuffs, interfaces and monitors, software products, traditional medical devices including syringes, as well as paper-based tools and systems.	IT systems – patient details: • Patient details need to be entered and checked several times across different systems and for different purposes, e.g., appointment booking, clinical management, diagnostic equipment, and reporting and communication with GPs. This creates delays and can lead to duplication and errors. Pacemaker – software: • The software and programming interfaces used with pacemakers are not standardised. Staff need to use five different operating systems with different features, and not all interface seamlessly with the

(*continued on next page*)

Table 3 (*continued*)

Work system element	Description	Characteristics
		configuration and reporting software. In some instances, data need to be downloaded onto a memory stick, which can lead to data loss and reporting inaccuracies. Headset for answering calls: • The receptionist uses a headset to make and to receive phone calls. The use of a headset enables the receptionist to be hands-free so that they can take notes and look up information from paper files more easily. However, patients walking into the reception area often are unable to recognise that the receptionist is on the phone, because the headset is a less visible indicator than holding a phone receiver to one's ear. This can cause confusion and even prompt challenging and aggressive behaviour.

4.2. Three overarching themes for design

Interactions between different elements of the work system were analysed and themed. Three themes for the design of cardiac diagnostic services in the community were developed. These are summarised in Table 4 regarding design opportunities and design considerations.

4.2.1. Promote autonomy and professional growth

CDCs offer the opportunity to create an environment that promotes autonomy, contributes to professional growth, and provides effective training in collaboration with an acute site. Cardiac diagnostic services in the community could be physiologist-led, with support for staff in these roles in the development of their leadership, management, and educator skills. Attractive career pathways should be offered to more junior members of staff through exposure to a variety of different clinical

Table 4
Summary of overarching design themes, design opportunities and design considerations.

Design Theme	Design Opportunities	Design Considerations	Data Examples
Promote autonomy and professional growth	• Physiologist-led services and development of Consultant Clinical Scientist role • Development of leadership and management skills • Promoting a sense of autonomy • Building and developing new clinical skills • Creating time and space for teaching and mentoring • Establishing shared teaching arrangements with acute site • Benefitting from teamwork and community atmosphere • Can help with recruitment and staff retention	• Ensure access to clinical expertise is readily available • Formulate clear and realistic escalation procedures • Formalise the relationship between the acute site and the CDC • Make use of staff rotation between acute site and the CDC • Develop shared training and supervision arrangements to provide access to diversity of diagnostic services and skills • Focus on digitally enabled and interoperable systems • Ensure convenient geographical location with transportation links and parking	"I see the potential to use this way of working to develop **leadership and management skills** with increased responsibility and independence." (*Interview, Services lead*) "I also thoroughly enjoy my **role as an educator** and see this as the perfect environment to increase capacity for student training where you have the space and time to teach without the pressure of acute emergency cases." (*Interview, Services lead*) "The **lack of consultant presence** is frustrating and can be a source of stress if we have an unwell patient we need to escalate." (*Interview, Senior physiologist*) "The community sites **only provide non-invasive diagnostics**, so this is not very appealing for already experienced senior physiologists and newly qualified or junior physiologists who are ambitious and want to go into more complex aspects of physiology." (*Interview, Senior physiologist*)
Focus on needs of patients in the community	• Move services closer to the patient • Utilise remote monitoring technology and home diagnostics • Integration of multi-professional and community teams to deliver one-stop shop vision • Allow patients time to mentally process and prepare • Patient confidence in local provision • Fewer DNAs	• Coordinate diagnostic services in the community with primary care and patient needs • Expand delivery of diagnostic services within GP practices • Ensure GPs have access to specialist expertise to reduce diagnostic referrals • Consider patients' psychosocial needs and how to navigate the system to improve patient experience and bring down DNA rates • Enhance administrative support with knowledge about local diagnostic pathways • Identify suitable geographical locations based on local needs to reduce patient travel times	"During the pandemic there was the rapid adoption of **remote working and new technologies**, for example in Holter monitoring, and this should continue and expand into the community." (*Interview, Services lead*) "Work more closely with community teams such as heart failure nurses. **Working in closer collaboration with multi-professional teams**, which would only serve to enhance clinical practice." (*Interview, Services lead*) "GPs really need **access to a cardiologist**, but that's not possible, so they order a lot of tests going down the diagnostic route instead." (*Interview, Senior physiologist*) "It needs a good administration team. **Not only understanding the patient but pathways.**" (*Interview, Divisional director)*
Facilitate communication across organisations	• Provision of a joined-up service • Improve patient experience • Decrease DNAs • Reduce administrative burden on clinical staff • Improve communication across services	• Improve processes around digital communication to facilitate email communication and phone calls between different stakeholders • Understand staff "work arounds" to highlight problems in communication processes and to inform solutions • Embed local knowledge and improve relationships to facilitate communication • Digitally enabled and interoperable IT systems	**Communication with GP practices:** The observations revealed instances where staff were reluctant to phone GPs to escalate test results due to concerns about the time this would require. On one occasion a member of staff was observed being on hold for 11 min while phoning the GP practice. (*Fieldnotes*) **Embedding local knowledge in communication:** Observations provided evidence of patient phone calls to the community cardiology department about services, which were not available. Patients had been directed incorrectly by the acute site to contact the community site. Administrative staff across the diagnostic pathways need to have sufficient local knowledge to understand how the pathways work, where information needs to get sent to, and whom patients should be contacting for information. (*Fieldnotes*)

skills. Creating such opportunities for career progression at different levels could help with recruitment and staff retention.

This needs to be underpinned by well-designed and clearly set out escalation procedures, which ensure access to specialist expertise when it is required, especially since there is not usually a consultant at the community site. Explicitly defined relationships with an acute site also enable shared training arrangements and staff rotation, ensuring that staff have exposure to a range of diagnostic services and patient presentations.

4.2.2. Focus on needs of patients in the community

CDCs can fulfil a patient-centred vision of diagnostic services delivered in the community to meet patients' needs. Patients should be able to access diagnostic services quicker and closer to their home, with some services potentially being delivered in patients' own homes using remote monitoring diagnostic technology. The one-stop shop approach to the delivery of diagnostic services, which integrates multi-professional and community teams to provide a diverse set of services, could reduce the need for multiple referrals and appointments. This approach needs to consider which diagnostic services are safe to be delivered in the community, while acknowledging that not every patient journey lends itself to this approach, e.g., more complex investigations that cross specialities and which require time for patients to mentally process and prepare for. This can increase patient confidence in the provision of services in the community and help reduce missed appointments (did not attend, DNAs).

The design of CDCs needs to be mindful that the patient journey is usually initiated in primary care. The patient's GP does the early diagnostic work, with several diagnostic services, such as ECGs, available in some GP practices. Part of the design of diagnostic services in the community should focus on enhancing diagnostic capacity in primary care and tailoring the relationship between CDCs and GP practices to local contexts to ensure GPs can access specialist expertise, e.g., a cardiac consultant. This could help reduce the number of referrals by GPs and result in fewer trips patients must make. CDCs should also draw upon local knowledge to make services more patient centred. This includes identifying suitable geographical locations to ensure that CDCs are accessible and that they are from a patient's perspective in more convenient locations than their next acute site. Utilising local knowledge can also improve administrative work, patient booking and DNA management, when staff have a good understanding of the patient population and the local diagnostic pathways across specialties.

4.2.3. Facilitate communication across organisations

While there is significant discussion of, and investment in, large-scale information technologies, the use of digital communication systems (e.g., email, messaging and video calls) as part of clinical processes has received less attention. Interoperability of IT systems and direct access to such systems remain challenging, but some of the problems experienced by healthcare workers at the frontline could be addressed with simpler digital communication solutions as part of a well-designed process. Ineffective digital communication processes, e.g., email communication between CDCs and GP practices, can lead to delays, duplication, and loss of trust. Conversely, digital communication technologies embedded in well-designed processes that consider the diverse needs of the different stakeholders can save time, deliver a more joined-up service, and improve patient experience.

5. Discussion

The findings of this study illustrate the complexity of clinical systems when looked at through a socio-technical systems lens. A human factors approach can provide insights into how a clinical vision of new service delivery models, e.g., around cardiac diagnostic services in the community and community diagnostic centres more generally, can be realised through purposeful design of interactions between the different elements of a clinical work system. The results provide design considerations based on the analysis of people and their requirements, tasks, tools and technologies, and the physical, organisational and external environment. In addition, looking at the interaction between these elements of the work system, the results also highlight three overarching design considerations around promoting professional growth and autonomy of the diagnostic workforce in the community, focusing on the needs of patients in the community, and facilitating communication across organisational boundaries. Such design considerations and opportunities can support the practical implementation of the vision set out in national policies, such as the Richards review.

The Richards review suggests expansion of specialist roles and the adoption of assistant practitioner and supporting roles. Individuals in such roles might lead diagnostic services as clinical specialists, such as musculoskeletal pathways, as well as services based on the needs of a patient population, e.g., leading imaging services for people with learning disabilities (Heales, Mills & Ladd, 2021). However, this intention needs to be underpinned by the development of appropriate career paths for advanced practice roles (Heales et al., 2021). In addition, the human factors analysis suggests that organisational factors, such as appropriate supervision arrangements (Coleman, Hyde & Strudwick, 2024), need to be put in place, which are supported by workable escalation procedures and suitable technologies.

The vision for CDCs as described in health policy is to bring diagnostic services closer to the patient and to enable GPs to refer patients to such community centres for diagnostic tests with a one-stop shop model, thereby reducing the need for patients to travel to a hospital to attend outpatient appointments. The human factors analysis highlights the importance of the physical environment, which suggests that this approach might work better in some geographical locations than others. In urban settings, patients as well as staff might find travel to a hospital more convenient, which could undermine one of the potential benefits of CDCs. In addition, there are significant differences in how people access care, and this can result in inequalities in health outcomes and patient safety (Chauhan et al., 2020; Douthit, Kiv, Dwolatzky & Biswas, 2015). While reducing health inequalities is an explicit ambition of the CDC vision, clarification and evidence are needed as to how CDCs address health disparities and contribute to equitable healthcare, with a significant gap in the research to date. For example, while CDCs might reduce travel burden for some patients, they might do so unequally by favouring more wealthy areas. Similarly, CDCs might reduce the complexity of accessing different diagnostic services, potentially reducing language and cultural barriers, but this is not a given.

Further, organisational factors, such as the impact on GP practices need to be considered. Involving GPs in designing new diagnostic pathways is crucial. However, this might also require GP practices to shoulder additional responsibilities, such as interpreting and acting on diagnostic test reports, potentially straining their already stretched resources (Samuel, Lennard & Richard, 2021).

While human factors can support the practical implementation of clinical visions for new service delivery models, this requires access to specialist human factors expertise and corresponding capacity in health systems, such as the NHS. At the moment, only very few healthcare providers employ human factors specialists as embedded practitioners (Catchpole, Bowie, Fouquet, Rivera & Hignett, 2021; Perry, Catchpole, Rivera, Henrickson Parker & Gosbee, 2021). Most human factors work happens as project-based research driven by universities, leading to a double-bind situation. University researchers and external specialists may lack deep exposure to the complexities of everyday clinical work, and may, thus, not fully grasp the nuances of work-as-done and the opportunities that exist in improving clinical systems. Similarly, healthcare organisations may struggle to recognise the potential value of human factors across the breadth of healthcare improvement work. While outsourcing to external human factors expertise has its place, the ideal scenario is, arguably, to have embedded human factors specialists working alongside clinical teams on an everyday basis (Catchpole et al., 2021). On the positive side, though, this is starting to change on the back of initiatives such as PSIRF. PSIRF is underpinned by a training framework for patient safety incident response leads and those in patient safety oversight roles. This training framework is intended to build expertise and capacity in human factors. The Health Services Safety Investigations Body (HSSIB), an independent national safety investigations body funded by the Department of Health and Social Care, offers free PSIRF training to individuals in the NHS in England. Similarly, the national patient safety syllabus, delivered by a team of Chartered Ergonomists at Loughborough University on behalf of NHS England, is seeking to equip patient safety specialists with a grounding in human factors. In the absence of dedicated human factors expertise within diagnostic departments, accessing these opportunities can help build the required capacity.

This study has some limitations. First, as a small-scale study of diagnostic services in a single community site, the findings might not generalise to other settings and locations. Second, the study participants did not include patients and their families who are served by the community site. Instead, consideration of patient needs relied on perceptions of these needs described by staff. Third, the design considerations identified in the study require further analysis and debate with a broader range of stakeholders due to their complex and political nature, which goes beyond the control of participants in the study. However, the illustration of the type of insights provided by a human factors analysis should be of wider interest as an approach to look at the design of cardiac diagnostic services in community settings, as well as other diagnostic services.

6. Conclusion

Delivering accessible and efficient cardiac diagnostic services in the community requires successfully bridging the gap between clinical vision and practical reality. This study used a human factors lens to illuminate system design considerations for transforming policy aspirations into practical improvements.

The gap between policy vision and practical reality remains a significant challenge in healthcare. The human factors approach demonstrated in this study offers a tool to help bridge this gap. The systems perspective focuses on the complexities of clinical work, the people and their needs, and the interactions of different elements of the clinical work system. Such an analysis can inform the design of effective interventions that translate policy goals into tangible improvements for patients, staff and healthcare delivery. The principles of this approach will be applicable beyond diagnostic services, and they could be used to address current policy aspirations, such as the design and meaningful use of healthcare artificial intelligence from a systems perspective.

Implementing a human factors approach requires access to specialised expertise. While current healthcare systems may lack dedicated practitioners, recent initiatives like the PSIRF training and the national patient safety syllabus in the NHS in England are paving the way for building this essential capacity. This study serves as a stepping stone, demonstrating the transformative potential of human factors in shaping the future of community cardiac diagnostics.

7. Impact statement

Integrating human factors expertise into community diagnostic services design and implementation teams can contribute to patient-centred and services and effective workflows. This requires access to specialised human factors expertise. Providers of diagnostic services could consider embedding human factors expertise into their settings and tap into existing educational human factors frameworks.

Ethical declaration statement

The study received organisational approval from the participating study site (St. George's University Hospitals NHS Foundation Trust). All participants provided consent to have their anonymised data included in the study.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Mark Sujan reports financial support was provided by NHS Health Education England. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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